Dairy and Type 2 Diabetes

Chris Cifelli, PhD
Vice President, Nutrition Research
National Dairy Council
Learning objectives

• Learn about what happens to the body with type 2 diabetes

• Gain an understanding of the most recent research on dairy intake and type 2 diabetes
The National Dairy Council works to promote dairy

The National Dairy Council, a non-profit organization funded by the dairy farmer checkoff program, has been committed to nutrition education and research-based communications for 100 years.
Nutrition research conducts sound science to support the importance of dairy for health and wellness.

Invest in research partnerships that catalyze innovation and health positioning.

- Public Health
- Consumer Benefits
Nutrition research program: Public health

- Dairy intake is associated with improved chronic disease risk
  - Decrease risk for cardiovascular disease
  - Decrease risk for type 2 diabetes
  - Maintenance of healthy body weight
  - Decrease risk for osteoporosis (poor bone health)
  - Decreased risk for hypertension and improved vascular function
Key definitions

- **Carbohydrates**: Sugar molecules linked together in “chain.” For example: sucrose

- **Glucose**: The simplest of all sugars. What the cells of the body use for energy

- **Insulin**: A hormone released by the pancreas that facilitates the entry of glucose into cells

- **Type 2 diabetes**: A disease characterized by abnormally high blood glucose levels because glucose is unable to enter cells properly.
What are carbohydrates?

- Carbohydrates are the major source of energy for people throughout the world
  - Simple sugars
  - Complex carbohydrates
  - Dietary fiber

- Provide 4 calories per gram
Carbohydrates are digested and broken down to simple sugars

- The body is able to efficiently break most complex carbohydrates down into simple sugars
  - Exception is dietary fiber

- The sugars are absorbed by the intestine and transported in the blood to tissues
  - Insulin facilitates entry into cells
  - Sugars are stored in cells or used for energy
What’s insulin and what does it do?

- Insulin is a hormone released by the pancreas that increases glucose passage into cells.
- “Key” that open “doors” on cells that let in glucose.
- Important for energy storage and usage by cells.

The hallmark of type 2 diabetes is insulin resistance.
Type 2 diabetes is related to the way the body processes carbohydrates

- Insulin resistance results in cells keeping the “doors” shut, increasing the amount of glucose in blood stream
Diabetes is a group of diseases in which blood glucose levels are above normal.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Type 1 Diabetes</th>
<th>Type 2 Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insulin Deficiency?</td>
<td>Yes</td>
<td>No*</td>
</tr>
<tr>
<td>Proportion of Cases</td>
<td>5 - 10%</td>
<td>90 - 95%</td>
</tr>
<tr>
<td>Risk Factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Viral infection that affects pancreas</td>
<td></td>
<td>• Obesity</td>
</tr>
<tr>
<td>• Young age</td>
<td></td>
<td>• Western diet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Physical inactivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Family history</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Age</td>
</tr>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Insulin injections</td>
<td></td>
<td>• Weight loss</td>
</tr>
<tr>
<td>• Diet &amp; exercise</td>
<td></td>
<td>• Diet &amp; exercise</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Some oral medications</td>
</tr>
</tbody>
</table>

*Not initially, but as the disease progresses there will be a deficiency of insulin.
Prevalence and public health burden

- **29.1 million** people in the United States have diabetes
- **86 million** people have prediabetes
- **$245 billion**: Estimated total diabetes medical costs in the United States
  - Medical costs for people with diabetes are twice as high as compared to those without diabetes

Source – Centers for Disease Control and Prevention
Consequences of type 2 diabetes are severe

- People with type 2 diabetes have an increased risk for
  - Heart disease and stroke
  - Hypertension
  - Blindness and eye problems
  - Kidney disease
  - Non-traumatic lower-limb amputation

“I think diabetes is affecting my eyesight. I have trouble seeing the consequences of poor food choices.”
What can be done to correct the problem?

• Nutrition and exercise are the cornerstones for diabetes management
  - Decreases risk of development
  - Decreases complications

• What is the appropriate nutritional strategy?
Dietary Guidelines point to an association between dairy consumption and lower risk for type 2 diabetes

“Moderate evidence also indicates that intake of milk and milk products is associated with a **reduced risk of** cardiovascular disease and **type 2 diabetes** and with lower blood pressure in adults”

How does the evidence fit together?
<table>
<thead>
<tr>
<th>Study</th>
<th>Endpoint</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malik et al. (2011)</td>
<td>T2D risk</td>
<td>• Dairy product intake of women during high school was significantly inversely associated with type 2 diabetes risk in adulthood</td>
</tr>
</tbody>
</table>
| Margolis et al. (2011) | T2D risk | • Low-fat dairy product consumption was inversely associated with the risk of type 2 diabetes  
• High yogurt consumption was associated with a significant decrease in diabetes risk |
| Fumeron et al. (2011) | Impaired fasting glucose/T2D | • Dairy products other than cheese were inversely associated with incident metabolic syndrome and IFG/T2D |
| Grantham et al. (2012) | T2D risk | • Dairy product consumption was inversely associated with the risk of type 2 diabetes in men, with a similar non-significant trend in women |
| Slujs et al. (2012) | Incident T2D | • A higher combined intake of fermented dairy products (cheese, yogurt, and fermented milk) was inversely associated with type 2 diabetes  
• No association between total dairy product intake and diabetes risk |
| Soedamah-Muthu et al. (2013) | T2D risk | • No association between total dairy or any dairy product and type 2 diabetes risk |
| Struijk et al. (2013) | Glucose and T2D risk | • Cheese intake was associated with improved glucose tolerance  
• Fermented dairy intake was associated with improved fasting glucose and HbA(1c)  
• No association with incident type 2 diabetes |
| Von Ruesten et al. (2013) | T2D risk | • No association between total dairy or any dairy product and type 2 diabetes risk |
| Louie et al (2013) | T2D risk | • No association between total and regular fat dairy and type 2 diabetes |
| Mozaffarian et al. (2013) | Incident T2D | • Trans-palmitoleate concentrations were associated with lower incident diabetes |
| O’Connor et al. (2014) | Incident T2D | • Low-fat dairy and yogurt intake were inversely associated with incident type 2 diabetes |
Meta-analyses show consistent benefits of dairy on type 2 diabetes risk

- A systematic review and dose-response meta-analysis of 7 prospective studies examined dairy intake and risk of type 2 diabetes

Dose-response meta-analyses show dairy associated with reduced risk of T2D

- More recent systematic review and meta-analysis of 14 cohort studies.

Consistency exists among dose-response meta-analyses

- Systematic review and dose-response meta-analysis examined dairy intake and risk of type 2 diabetes among 17 prospective studies

What about whole milk and full-fat dairy?
High dairy intake is associated with lower incidence of type 2 diabetes

- Those with high dairy intake in high school had a 38% lower risk for developing type 2 diabetes as adults
- Need to sustain dairy intake in adulthood to maximize risk reduction
- This relationship was driven primarily by full-fat dairy consumption

Higher blood levels of a dairy specific fatty acid are associated with a lower incidence of type 2 diabetes

Relative Risk of Incident Diabetes

Quintiles of Trans-Palmitoleic Acid in Blood

Drawn from Mozzafarian et al. Ann Int Med, 2010
How do the clinical data pieces fit together?
Dairy intake improves insulin levels

- Overweight or obese adults with metabolic syndrome (pre-diabetes)
- Assigned to receive adequate or low dairy weight maintenance diet for 12 weeks

Adapted from: Stancliffe et al. *Am J Clin Nutr*, vol. 94, no.2 2011
Dairy intake improves glucose and insulin after only 6 weeks

- Thirty-four subjects who habitually consumed ≥2 sugar sweetened beverages and were at high risk of developing type 2 diabetes participated in this randomized, crossover study.

Baseline

6 weeks

DAIRY
2 servings of milk and 1 serving of yogurt

CONTROL
2 servings of soda and 1 serving of pudding

2 weeks

6 weeks

CONTROL
2 servings of soda and 1 serving of pudding

DAIRY
2 servings of milk and 1 serving of yogurt

Maki K et al. FASEB J. 2014; 28:117.3
Dairy intake improves glucose and insulin after only 6 weeks

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline</th>
<th>Dairy (Δ)</th>
<th>Control (Δ)</th>
<th>Difference</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting Glucose</td>
<td>99.1 (1.5)</td>
<td>1.4 (1.1)</td>
<td>3.4 (1.2)</td>
<td>-2</td>
<td>0.136</td>
</tr>
<tr>
<td>Glucose AUC$_{0-120}$</td>
<td>14905 (501.8)</td>
<td>82.3 (273)</td>
<td>323.3 (299.9)</td>
<td>-241</td>
<td>0.482</td>
</tr>
<tr>
<td>Fasting Insulin</td>
<td>7.3 (6, 10.2)</td>
<td>-0.1 (1.2, 1.8)</td>
<td>1.2 (0.3, 3.2)</td>
<td>-1.3</td>
<td>0.036</td>
</tr>
<tr>
<td>Insulin AUC$_{0-120}$</td>
<td>9662 (779.8)</td>
<td>-285.3 (613.7)</td>
<td>-257.3 (624.0)</td>
<td>-28</td>
<td>0.982</td>
</tr>
<tr>
<td>Insulin Secretion Index</td>
<td>0.6 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0.0 (0.0)</td>
<td>0</td>
<td>0.743</td>
</tr>
<tr>
<td>Disposition Index</td>
<td>2.6 (0.2)</td>
<td>0.0 (0.1)</td>
<td>-0.4 (0.1)</td>
<td>0.3</td>
<td>0.011</td>
</tr>
<tr>
<td>HOMA2-%S</td>
<td>117.8 (86.2, 147.1)</td>
<td>1.3 (-21.3, 29.3)</td>
<td>-21.3 (-33.1, -3.3)</td>
<td>22.6</td>
<td>0.009</td>
</tr>
<tr>
<td>HOMA2-%B</td>
<td>72.6 (3.0)</td>
<td>-1.9 (3.1)</td>
<td>5.3 (3.6)</td>
<td>-7.2</td>
<td>0.105</td>
</tr>
</tbody>
</table>

Maki K et al. *FASEB J.* 2014; 28:117.3
Mechanism of action may be due to the unique nutrient package of milk and dairy

* Niacin equivalents
Putting the pieces together: What does the science truly say?

“Moderate evidence also indicates that intake of milk and milk products is associated with a reduced risk of cardiovascular disease and type 2 diabetes and with lower blood pressure in adults”

2010

• The preponderance of evidence indicates that dairy can reduce type 2 diabetes risk, including full fat dairy
• “Consumption of dairy foods provides numerous health benefits including lower risk of diabetes, metabolic syndrome, cardiovascular disease, and obesity” (2015 DGAC Report)